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SCIENCE

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RELATIONS OF THE AMERICAN ASSOCIATION TO THE NATIONAL ACADEMY[1]

THE advancement of science, for which both the National Academy and the American Association stands, has, in the last century, come to represent a great profession of many branches. The number of professional scientists has increased very remarkably in the last half-century in our country, and it continues to increase at an accelerated rate. Science is becoming recognized as one of the important professions. A young man may now look forward with assurance to a professional career in science.

The new science profession embraces both research and teaching, the securing of new knowledge and the distribution of knowledge that has already been secured. The two are obviously closely allied, but they represent different aspects of the advancement of science, both of which are necessary. Scientific research includes investigations of both the "pure" and the "applied" kinds and these also represent different aspects of the same general endeavor, although they are not readily separated when one attempts a categorical classification. And science teaching embraces many kinds of work; from elementary instruction to the guidance of candidates for the doctor's degree of a university, from special consultation to the giving of public lectures, from the writing of popular stories on science subjects to the preparation and editing of technical contributions in the several special branches.

Coordinate with the development of this complex professional field has developed an increasing need for the organization of scientists, which has been met by the formation of many special societies, each aiming to hasten the advance of science along a particular line or group of related lines. These are devoted to the advancement of the sciences rather than to the advancement of science. Their journals and their meetings are of and for specialists.

Before the advent of these societies mathematics and the natural sciences had their general organizations in the National Academy, the American Association, the American Philosophical Society, the American Academy and a number of state academies. Their meetings tended to bring together specialists

[1] Address given at the dinner of the National Academy of Sciences, at Urbana, Ill., October 19, 1927.

in widely different fields and their publications aimed to present scientific advance in the several branches of research without too much classification into specialized groups. In their later development these organizations have maintained themselves and some of them have retained great prestige and importance, but the growth of so many special societies, with their journals and their meetings and their dues, has undoubtedly detracted from the generalizing influence of the broader organizations.

In recent decades it has been realized and remarked by many minds that the unquestionably great gain to science that has resulted from the formation and activities of the special societies has not been secured without considerable and serious losses in the realm of scientific synthesis, in the broad appreciation of knowledge as a whole. I touch here on the frequently discussed problem of over-specialization in individual intellectual workers, which is reflected in our organizations. Modern specialization in science tends to promote remarkable ignorance and even intolerance in regard to fields not closely related to the one specialized in. I am reminded of a brilliant schoolmate of mine who did not care even to dip into the writings of Thomas Carlyle because he had not yet read all of what Charles Darwin had written. I am also reminded of a pungent remark once made to me by a Russian agricultural scientist trained under the imperial régime. "The staff members of your American bureaus and stations for agricultural research," he said, "are mainly uneducated experts." It has been very aptly said that "a specialist is a man who knows more and more about less and less."

Under the analytical influence, the American Association became subdivided into sections similar to those of the National Academy. Under the synthetic influence, as the special societies came forward, an arrangement was perfected by which, as affiliated organizations, they take part officially in directing the affairs of the association.

A further movement toward the interchange of ideas between different groups of specialists was inaugurated just before and during the Great War. Through cooperation of the National Academy and the American Association were organized the beginnings of the National Research Council, which has subsequently developed so satisfactorily and fruitfully under the leadership and sponsorship of this academy.

The association tries to further the interchange of ideas among scientists working on apparently divergent lines and it enjoys the cordial cooperation of the National Research Council. Wherever it has been in a position to do so the association has been glad to aid in work undertaken by the council. I must add, however, that my Washington office has, I fear, thus far received more help from Dr. Kellogg's office than his has received from mine. It is a pleasure to acknowledge at this time many valuable aids that have been had by the association from the Research Council.

Toward a further broadening of scientific specialization, if you will permit me to employ such an expression, we may work, I think, in about six general ways: (1) by bringing together scientists from different fields of science, as in committees of various kinds that may inaugurate and direct large movements and cooperative research projects, (2) by arranging and maintaining general-science publications for scientists, (3) by arranging scientific meetings for all kinds of scientists and others interested in science, (4) by encouraging an *esprit du corps* among scientific workers in general, (5) by undertaking to secure such modifications of the methods of school and college education and university training as may be promising and feasible, and (6) by aiding and encouraging the publication of popular but truthful accounts of scientific knowledge. All these lines of work are represented in projects that are engaging the attention of the National Academy and the association. The first is exemplified in the scientific divisions of the Research Council and in the sections of the association, in their efforts to maintain a sort of perpetual exchange among the different special societies and among different groups of research workers as well as among the individuals of each group.

An excellent example of a general-science publication calculated to encourage individual cooperation and to promote broader appreciation, is the American Association's official journal, SCIENCE. Throughout a third of a century, under the far-seeing and efficient guidance of Dr. Cattell, SCIENCE has added its increment of broadening influence week by week. It has played an important part in gaining and maintaining the membership of the association and one of the most tangible of the association's accomplishments is the arrangement by which this journal has so long been its official organ. As you all know, the present owner has generously made an agreement with the association by which the journal will eventually become the property of the organization. You are familiar with the *Proceedings* of the National Academy, which aims to secure wide circulation of original announcements of the results of American research among investigators in all branches of science. The publications of the National Research Council are also to be mentioned here with great appreciation.

The scientific meetings of the academy bring to-

gether many kinds of scientific workers and have always tended toward the end we are here considering. In a broader way the annual meetings of the association contribute in the same direction. By combining its meetings with those of many of the special societies the American Association has brought together probably the largest gatherings of all kinds of scientists that have ever occurred. The salutary influence of these conventions, where workers in widely different fields have opportunity to become mutually acquainted, can not, I think, be overestimated.

With their continued increase in size and complexity the annual meetings of the American Association are becoming a serious financial problem. Locally raised funds are generally very inadequate and dues and registration fees are purposely kept as low as possible. The association very much needs a substantial endowment for the holding of the annual meetings, which are surely almost a national necessity now and which can not be expected to be self-supporting. I should like here to make a personal suggestion that the National Academy might perhaps be interested to aid in finding means by which the effectiveness of these annual conventions may not be curtailed through too great economy.

Through the democratic nature of its organization and through the publication of its official journal the American Association cultivates the feeling among all of us scientific workers that we all belong together, no matter how wide may be the apparent separation of the scientific details with which we deal individually. We are now a happy family of nearly 15,000 members. In this part of our endeavor to bring science home to the scientists the National Research Council is also actively engaged.

The very fundamental project of improving the education of those who are soon to be the future scientists and appreciators of science is of course primarily the concern of the Education Section of the association. With that section are affiliated several societies, including the National Education Association. Other sections deal with the same project. A special committee of the American Association as a whole, on the place of science in education, is making a special study of present trends in this very important branch of scientific work, for the science of the future will depend on the education of the present. The National Research Council has also taken a prominent part in this line of work.

The general education of the public at large, in scientific matters, and the cultivation of public appreciation of what professional workers in science are trying to accomplish are being carried on especially by Science Service, for the guidance of which the National Academy, the National Research Council and the American Association are jointly responsible. An important feature of recent annual meetings of the association is a well organized news service, which aids the representatives of the press and other non-technical writers to secure information about the papers presented at the meeting and to make personal contacts with the scientists.

I have tried to bring before you some of the main ways in which an important present trend of the best scientific thought is being jointly supported by the National Academy and the American Association. The two organizations cooperate in many other ways and we hope that new ways may be developed from time to time. The select nature of the academy and its consequent reliability and prestige make it logically the upper house in the parliament of American science workers, as Cattell has remarked, while the democracy of the association and the fact that most young scientists, as well as those of riper experience, are enrolled as members and are actively interested in its work, make it logically the lower house.

BURTON E. LIVINGSTON

THE ACTIVITY OF NERVE[1]

UNTIL the nineteenth century practically all hypotheses as to the nature of conduction assigned to the nerve fiber a passive rôle. Energy or substance entered at one end and was carried to the other, where it produced its effect. In the middle of the eighteen hundreds the production of an electric change by nerve during activity was discovered; and later were found, first, the existence of a refractory phase for a few thousandths of a second after an impulse had passed during which a nerve could not transmit a second impulse, and, second, the independence of the intensity of the effect produced from the intensity of stimulus applied. These facts indicated the active participation of the nerve fiber in carrying the impulse. In the early years of this century it was further found that a nerve slowly lost its conductivity under conditions of asphyxia and recovered with oxygen, suggesting an oxidative basis for this activity. Attempts to follow the respiration of nerve were partly successful, but careful experiments failed to demonstrate the production of heat (which must accompany oxidations) during nervous activity, so the interpretation of chemical findings was rendered very uncertain.

The series of researches to be described,[2] carried out in the laboratories of Professors Hill and Meyerhof,

[1] Summary of a lecture delivered at the Biochemical Laboratory, Cambridge University, August 2, 1927.

[2] See R. W. Gerard, *Am. Jour. Physiol.*, LXXXII, 381, 1927, for further details and literature.

began with a redetermination of the heat production of nerve. Isolated frog sciatics were arranged for stimulation at the upper end, the lower halves resting on a thermopile so wound as to bring several hundred insulated constantan-silver junctions against the nerve. Although the thermopile sensitivity under these conditions was about 2,000 microvolts per calorie liberated, tetanization of the nerves for ten seconds at 280 shocks per second gave only about one tenth of a microvolt. Through the thermopile and galvanometer resistances currents of about 10^{-10} amp. would result, which are much too small for even high sensitivity galvanometers. A successful means of amplification was found; the thermopile current passed through a sensitive moving coil galvanometer, the mirror of which reflected a strong vertical beam of light. At rest this fell half way across the slit of a radiation thermopile, setting up a constant potential and current through a second sensitive moving magnet galvanometer connected with it. Movements of the first instrument of a small fraction of a millimeter allowed more or less of the reflected light and heat to reach the thermopile and, by varying the potential this produced, gave large deflections of the second galvanometer. The sensitivity of the whole system was 2×10^{-12} amp. = 1 mm. deflection at 1 meter, and tetanizing the nerves gave deflections of about 200 mms. For purposes of calibration a known amount of heat could be produced in the nerves by passing an alternating current, too weak to stimulate, through their length.

It was soon found that the deflection during tetanization at 280 shocks per second at 15° C. corresponded to a liberation of 7.6×10^{-6} cal. per grm. per sec. The deflection, however, fell very slowly, requiring ten minutes after stimulation was stopped to return to zero, whereas a current heat deflection was over in less than a minute. It was obvious, therefore, that nerves continued to produce heat for about ten minutes after they had been active, and comparing the areas of the curves for nerve heat and current heat showed that the total heat produced per gm. and sec. stimulation was 6.9×10^{-5} cal. The resting heat production had to be determined indirectly from the change in base line when a nerve was asphyxiated, and was found to be 2×10^{-5} cal. per gm. and sec., to which the above values are an addition.

Analysis of the galvanometer curves obtained by stimulation yielded information as to the amount of heat produced second by second and showed that nerve, like muscle, produces its heat in two distinct phases. For each impulse there is an outburst of heat lasting a few thousandths of a second which is followed by a feeble but prolonged heat liberation. Although the rate of heat liberation in the initial phase is 5,000 times as great as at the start of the delayed, only 11 per cent. of the heat is produced during the first phase, the remainder appearing in the delayed one, most at first and slowly fading out.

The values given so far were determined by tetanization at 280 shocks a second. To obtain the absolute heat production for a single impulse, stimulation was carried out at different frequencies and the heat production of the nerve measured. The heat per second does not rise as fast as the frequency, so that the heat per impulse falls as successive impulses follow one another more and more closely. The fall is already apparent when impulses are as much as .030 sec. apart, so that the effect of one impulse lasts longer than this time. Presumably when an impulse traverses a nerve some energy-giving reaction takes place, and the reactive substance is then rapidly reformed. If all that is present at any time is discharged by an impulse, the return of heat-producing power gives a measure of the course of reformation. Also since reformation is very probably itself accompanied by wastage of energy and heat formation, the initial phase of heat may well be made up of two subsidiary phases, one accompanying conduction itself and the second accompanying the immediate restitution of the system. Aside from these considerations, the frequency experiments showed that at 280 per second each impulse gives only one fourth as much heat as an isolated one, so that the initial heat per impulse per gm. of nerve is 10^{-7} cal., and the total heat almost exactly one millionth of a calorie. For a single impulse traversing 1 cm. length of a single fiber the values are one millionth of these.

Further insight into the underlying chemical processes was gained by studying the effect of oxygen-lack on heat production and later by direct chemical studies. In the well explored case of muscle, it has been found that the initial phase of heat production accompanying contraction is independent of oxygen and is associated with the formation of lactic acid from glycogen, whereas the delayed phase occurs only when oxygen is available and is associated with oxidation of about one fourth of the lactic acid and reconversion of the remainder into glycogen. In absence of oxygen, a muscle is able to continue activity for a long time, securing its energy from the formation of lactic acid which then simply accumulates. The picture of nerve activity is essentially different; for in absence of oxygen both initial and delayed heats fall gradually to practical extinction in about three hours (at which time the nerve is asphyxiated and also loses its power of conduction) but the ratio remains the same throughout. The fall in heat is probably due largely to a gradual failure of one fiber after another, though the heat in each fiber is also probably less,

due to conduction of subnormal impulses. These results are better interpreted with the aid of data on respiration.

Isolated sciatics were placed in small glass chambers with electrodes fused through the walls and fitting by ground glass joints to one or both limbs of a manometer. With alkali present in the chamber to absorb CO_2 any volume decrease represented oxygen consumed; and with opposite nerves in chambers on the right and left limbs of a manometer the resting oxygen consumption balanced out and the effects of stimulation of one side were obtained directly, with an error of only a few per cent. With no alkali present, the CO_2 produced could also be estimated. Experiments carried out under the same conditions as those on heat production showed the resting oxygen consumption to be 16 cmm. per gm. and hour, and the increase on stimulation (when tetanized with 280 shocks a second for twenty-two seconds every four minutes) 61 cm. per gm. and hour stimulation. The oxygen needed to produce the previously measured heats, if these were entirely due to oxidation of ordinary foodstuffs, is 14 cmm. for the resting and an extra 48 cmm. for the active states; so that there is little question that all the energy of the resting as well as the active metabolism is obtained by oxidations. Further, the extra oxygen consumption does not appear or cease sharply with the start and stop of stimulation, but shows a lag of about a quarter of an hour before reaching its maximum at start or its zero at stop, indicating that much, if not all, the oxygen consumption is delayed in time, corresponding to the delayed heat.

The R. Q. during rest is 0.77 (between 0.75 and 0.80), corresponding to the burning of a mixture of fats, proteins and carbohydrates. The R. Q. of the extra metabolism of activity is 0.97 (between .95 and 1.0), corresponding to the burning of carbohydrates, though the R. Q. of protein would also be 0.95 if the nitrogen ended in the form of ammonia rather than urea. As a matter of fact, about 0.45 mgm. per cent. of extra ammonia is formed during an hour of continued activity which, if all freed by protein oxidation, would mean enough protein oxidized to account for the oxygen consumed. It is improbable that the ammonia comes from this source, for at rest 0.2 to 0.3 mgms. per cent. of ammonia per hour is also formed, and equally whether the nerve is in oxygen or nitrogen, but pending further evidence it is not safe to conclude that carbohydrate is the sole fuel used by nerve for its activity.

Another significant fact appears when stimulation is continued without interruption rather than for short periods with rests between. The extra oxygen consumed then is only 18 cmm. per gm. and hour of stimulation, though this value may be maintained for several hours. The heat production per stimulus is also decreased when stimulation is repeated at short intervals. It appears, therefore, that the amount of energy a nerve can liberate per unit time of activity depends upon what fraction of the total time is spent in activity and what in rest. For short periods of activity it is able to discharge more energy than for longer ones. This can hardly be a "fatigue," in the sense of progressive failure due to activity, since the characteristic level of energy liberation is reached within a few minutes after any particular type of stimulation is begun and then remains constant for hours. It is suggested, therefore, that this coming to some equilibrium value be called "equilibration."

The evidence so far presented shows that during activity (as well as rest) a nerve obtains all its energy ultimately from oxidations. Little, or none, of the oxidations accompanies the nerve impulse itself, but rather they follow in the next 10–15 minutes; so at least two processes, probably three, occur in sequence. These can not be segregated or separated in time by oxygen lack, but after the impulse has been conducted the whole series of changes must run to completion in the usual manner. By analogy with muscle the thought occurs that the first stage is the formation of lactic acid and the last is its oxidation. (The ratio of initial to delayed heat is 1:9 instead of 1:1.5 as in muscle, which would correspond to the production of lactic acid followed by its total oxidation rather than partial restitution to glycogen.) If this were so, and the second stage must follow the first, no lactic acid should accumulate as a result of activity even in the absence of oxygen.

Sciatic nerves resting in nitrogen produce lactic acid, as do most other tissues. The production starts slowly and reaches a maximum rate of about 7 mgm. per cent. per hour in two to three hours after a nerve is put in nitrogen, then gradually falls to zero. If glucose (but not levulose or galactose) is added to the solution containing the nerves lactic acid formation continues at the maximum rate for days or until all the added glucose has been used up. Without added glucose about 100 mgm. per cent. lactic acid is formed in all, in 30 hours at 15° C., in seven to eight hours at 28° C., and there is in fresh nerve just about this quantity of carbohydrate. These facts leave little doubt that nerve will form lactic acid when kept in nitrogen as long as any precursor is available, and that the main precursor is glucose. These figures are similar to those for muscle, as is also the resting oxygen consumption, and indicate no great dissimilarity between the resting processes in the two tissues.

On stimulation in nitrogen, however, the story with nerve is entirely different, for, as anticipated from

the previous evidence, there is no increased accumulation of lactic acid. If more is formed it is also oxidized and, indeed, there is no direct evidence that lactic acid appears even as an intermediary step in the breakdown of sugar accompanying nerve conduction.

The picture now arrived at is, of course, very sketchy, but two questions require attention before even the broad outlines are complete. First, if the processes of conduction ultimately depend on oxidations, why can a nerve continue activity for several hours in nitrogen? Second, since most if not all the oxidations and energy changes occur after the impulse has been conducted, how do they enter into the system and why are they so essential? The answer to the first seems fairly definite. Nerve contains substances which are in an oxidized state when oxygen is present but can be reduced in its absence and so permit oxidations in the tissue—*i.e.*, an oxygen, or better oxidizing, reserve. Glutathione, cytochrome and similar respiratory intermediates might play such a rôle and, with some assumptions, it may be calculated that glutathione in nerve might alone permit oxidations for an hour's activity. Experimentally it is found that when a nerve is exposed to oxygen after two hours in nitrogen it takes up during the first hour in oxygen considerably more of this gas than later on; in fact, the extra oxygen taken up is about two thirds as much as it would normally have used during the time in nitrogen. Still more direct evidence is found in the fact that, kept over night in nitrogen, a nerve actually *produces* 10–15 per cent. as much CO_2 as it would in the same time in oxygen, and presumably most of this appears in the first few hours. Finally, nerve as other tissues does not produce lactic acid during rest as long as oxidations are in progress and, as stated, the lactic acid production does not get under way for about two hours after a nerve is put in nitrogen. All these facts suggest that, due to a reserve, oxidations may continue several hours after external oxygen is excluded—and during this time a nerve continues in fact to be able to conduct.

The second point has not yet been answered, but some evidence is available. The simplest assumption for the first reaction, accompanying conduction, is that some substance, presumably carbohydrate, is changed to another, $C \xrightarrow{O_2?} X$; and in the second delayed stage $X + O_2 \rightarrow CO_2$. This can not, however, be correct, for after a few hours in nitrogen there is still plenty of C left and accumulation of X is apparently unable to inhibit the first reaction, at least if X is diffusable, for a nerve kept in gas fails no sooner than one in fluid. This would mean that cutting out the second reaction could have no influence on the future carrying out of the first. Such an influence would be present, however, if an accessory substance A, necessary for the first reaction, were changed to an inactive state A^1 in the first stage and returned to its original form by the second. (The change might conceivably be a physical rather than a chemical one.)

$$C + A \xrightarrow{O_2?} X + A^1 \quad \ldots\ldots 1$$

$$X + A^1 \rightarrow CO_2 + A \quad \ldots\ldots 2$$

This scheme is still too simple, as it ignores the changes immediately following the conduction of an impulse, while a nerve passes from the absolutely refractory period to normal conductivity and energy liberating capacity. This intermediate change implies a third reaction, and very probably it is this one that fails as a result of the absence of the delayed changes. The skeleton of the complete system[3] would then be:

$$C + A \xrightarrow{O_2?} X + A^1 \quad \ldots\ldots 1$$

$$A^1 + E \xrightarrow{O_2?} A \quad \ldots\ldots 2$$

$$X + O_2 \rightarrow CO_2 + E \quad \ldots\ldots 3$$

in which the extra factor E is needed to restore A^1 to A and is produced only during the final reaction.

With a limited quantity of the A, A^1 system and a variable excess of E, this hypothesis accounts for the facts given above, as well as many others. During conduction all A present changes to A^1; if less than the normal amount be present the impulses are of subnormal intensity and produce less heat, if less than a critical value conduction is entirely suspended. During the refractory period, reaction 2 restores A, the absolutely refractory period lasts until the critical amount of A is restored, the relatively refractory one until restoration is complete. Reaction 3 is relatively extremely slow, lasting 10 minutes, so that with activity the amount of E falls until an equilibrium is reached between its formation and use. For repeated activity of a few seconds with minutes of rest between, the resting concentration of E will be practically maintained and reaction 2 and so 1 proceed as after rest. But as the activity is prolonged and rests shortened the restoration of E will lag further and further behind, reaction 2 will be progressively slowed and subnormal or less frequent impulses will result. This corresponds to the process of equilibration shown by heat production and oxygen consumption (and

[3] This may also be expressed, to indicate better the nature of reactions 2 and 3 as a means of "winding up" the mechanism for reaction 1, as follows:

$$CA \rightarrow A^1 + X \quad \ldots\ldots 1$$

$$C + A^1 + E \rightarrow CA \quad \ldots\ldots 2$$

$$X + O_2 \rightarrow CO_2 + E \quad \ldots\ldots 3$$

action current as well). It has been found by Field and Brücke, which accords with this hypothesis, that the refractory period steadily increases with continued stimulation for at least 10 minutes and recovers during rest. After equilibrium is established, in several minutes, no further change takes place as long as the same stimulation is continued, until in many hours fatigue, possibly due to exhaustion of C, sets in.

Absence of oxygen interferes with reaction 3. In nitrogen the oxidizing reserve permits it to continue for some time, but more and more slowly as the reserve is used up, and finally it ceases entirely. The amount of E will correspondingly slowly fall and, exactly as above, reaction 2 and then 1 be interfered with and weaker and less frequent impulses be conducted; the system eventually tending, however, not to equilibrium but to completion with failure of conduction. The fall in heat, prolongation of refractory period reported by Fröhlich and by Kato, spreading out of action current, etc., that accompany the course of asphyxia all find their explanation on this basis.

Other phenomena of nervous activity are in conformity with this scheme, but it is not wise to press it further till more definite knowledge of the actual changes postulated is available. At present there is evidence that other changes than the direct energy yielding ones are indeed present, but what rôle they play, if any, remains to be determined. The formation of ammonia has been mentioned and there are also changes in phosphates (unpublished observations). In fresh nerve there is about 60 mgm. per cent. of "soluble" phosphate (expressed as P_2O_5), of which less than half is free inorganic and the remainder partly in an acid labile combination (phosphagen?) partly in an acid stabile one (lactacidogen?). Long standing in oxygen has little effect on the distribution, but standing in nitrogen sends all or nearly all of the phosphate into the inorganic form.

It remains to correlate this material with some actual mechanism of conduction. The current view that activity of one portion of a nerve fiber is the stimulus to the adjacent portion and so along the entire fiber has much to support it, especially in the form developed by Lillie. Recent evidence indicates that conduction itself may be analyzed into two phases occurring repeatedly in succession. The first is an explosive type of chemical change in a portion of the membrane surrounding the nerve fiber, and it leads, probably by local potentials, to ion movements within the fiber, which constitute the second phase. Local concentration of ions against an adjacent portion of membrane initiates here the explosive change, and so on. Probably the ion movements are associated with only a small fraction of the energy changes, and all the material presented above concerns itself mainly with the behavior of the membrane during and after conduction. Reaction 1 would thus be the one directly entering into conduction, the explosive change determining by its intensity the amount of potential developed, the distance ahead that adequate ion movements take place, and so the intensity and speed of the nervous impulse. Most factors affecting conduction act primarily through the membrane reactions, but some, as for example diameter of the nerve fiber, may act through the ion changes. It seems not impossible to account for the phenomena associated with the activity of nerve along the lines here sketched; and, recalling that the metabolism of central nervous tissue is several hundred times as intense as that of peripheral nerve, there appear to be available many new data to help account for such reflex phenomena as summation and fatigue.

R. W. GERARD

UNIVERSITY OF CHICAGO

HAWAII'S TRIBUTE TO DR. NEWCOMBE

DR. FREDERICK CHARLES NEWCOMBE, professor emeritus of botany and retired head of the department of botany at the University of Michigan, died in Honolulu, T. H., October 1, 1927, aged sixty-nine years.

On account of failing health, Dr. and Mrs. Newcombe had made their home in Honolulu since October, 1923, soon after Dr. Newcombe's retirement from the university. Mrs. Newcombe died July 10, 1927.

Although never of robust physique, Dr. Newcombe was an indefatigable worker. Even after coming to Hawaii, he continued his researches on the sensitive reactions of plants at the Hawaiian Sugar Planters' Association with which he was associated.

The rare opportunity was afforded Dr. Newcombe, after retirement from a long, active career of teacher, research worker, executive of his department, editor and counselor to many, to carry his endeavors into a new and different environment. Here he not only continued research in his chosen field, but became a leader in the scientific thought and life of the territory. Few indeed, even if they had not been burdened as he was by failing health and the strain of the long, fatal illness of a loved one, could have grasped such an opportunity. It is a tribute to the man's undying loyalty to the work he loved, to his keen mind, tactful optimistic personality, indomitable will power and sound judgment, which never permitted him to do anything hastily, that he was able, in spite of anxiety, physical and mental suffering, to gather together and unify into two working organizations the many diverse scientific interests of the

territory. Where others had failed Dr. Newcombe succeeded. In a quiet unassuming manner, he led in the gathering together of a small group of botanists and the organization of the Hawaiian Botanical Society, April 7, 1924. He became the first president of the new organization and by the end of his presidential year its success was assured. Its growth and development have been steady.

In the same manner, through his influence, a larger group with more diversified scientific interests gathered at the University of Hawaii and there under his leadership the Hawaiian Academy of Science was organized July 23, 1925. Again he served in the capacity of first president during the first critical year of its existence, giving freely of his time, energy and the wisdom of his deep rich life. The successful year closed with a four-day session devoted to the reading of papers bearing on various scientific subjects of interest. The Hawaiian Academy of Science has continued its active growth.

Dr. Newcombe's helpfulness to the cause he loved did not end with the organization of these two societies. The latchstring of his study was always out. Never was he too busy, too tired or too engrossed with his own affairs to pause and help with advice, suggestion or criticism a fellow worker. In fact it seemed as if he could not do or give freely enough from his rich life. Age, sickness and sorrow did not dim the brightness of his great mind. He remained, as he would have wished, in full possession of his mental faculties until a few hours before his death. As he approached the sunset of his life, those who knew him best felt a softening and a mellowing of his natural austereness. Many an eye was moist at the close of the simple service held in his home, where alumni of the University of Michigan, friends and scientists had gathered in the hush and quiet of the late Sabbath afternoon, to pay tribute by word and profusion of flowers to the memory of a great teacher, scientist and friend. His passing means much to the community at large, to the scientific world and to his friends here and on the mainland.

As student and author of many articles on original research, as teacher, counselor and inspiration to his students and fellow workers, Dr. Newcombe has exercised a dominating influence in the advancement of scientific thought in America.

ELIZABETH DOROTHY WUIST BROWN
BERNICE P. BISHOP MUSEUM,
HONOLULU

SCIENTIFIC EVENTS

THE AUSTRALIAN NATIONAL RESEARCH COUNCIL

THE annual general meeting of the Australian National Research Council was held in Melbourne on August 25 and 26. According to a report printed in *Nature*, particular attention was given to the financial position of the council in relation to present and future work. The offer of the Carnegie Corporation to provide a sum of £5,000 as the nucleus of a research fund was accepted with most cordial thanks, and with this sum and more than £1,000 available from other sources, such a fund was formally instituted. A strong committee was appointed to take action for securing additional contributions from Australian sources, and it is hoped that before long the council will be in a position to give considerable aid to Australian workers in pure science. Amongst several satisfactory reports on the year's work was one from the anthropology committee outlining the progress made since the initiation of the department of anthropology in the University of Sydney. This step followed upon a resolution by the second Pan-Pacific Science Congress of 1923 and was made possible by contributions from the commonwealth and state governments and the Rockefeller Foundation. The new department is now in full swing and is taking active steps to organize investigations both on the mainland and on the neighboring Pacific islands. The following new members were elected to the Australian National Research Council, the total membership of which may not at any time exceed 100: Mr. C. R. P. Andrews (director of education, Western Australia); Professor A. R. Radcliffe Brown (anthropology, University of Sydney); Professor A. N. S. H. Burkitt (anatomy, Sydney); Professor A. J. Ewart (botany, Melbourne); Dr. W. A. Hargreaves (government chemist, South Australia); Professor J. W. Paterson (agriculture, Perth), and Dr. H. R. Seddon (Veterinary Research Station, New South Wales).

The trustees of the Commonwealth Science and Industry Endowment Fund in Australia are this year making £1,250 available in small grants for the assistance of scientific workers in Australia. The lines which will be followed in making the grants will be similar to those which have been proved to be satisfactory by the Department of Scientific and Industrial Research in Great Britain. The Commonwealth Fund has an invested capital of £100,000, and it is provided by act of parliament that the interest from it shall be employed for the dual purposes of training students in the methods of scientific research and in providing assistance to persons engaged in research, irrespective of whether their work has an obvious practical application or not. At present, the income is being devoted mainly to the first object, but as time goes on it is expected that an increasing sum will be available annually for distribution in grants.

LECTURES BY INDUSTRIAL FELLOWS AT THE MELLON INSTITUTE

THE following course of lectures on technologic subjects, by specialists engaged in scientific investigation

in the Mellon Institute of Industrial Research of the University of Pittsburgh, are being given at 11:30 A. M. to 12:30 P. M. (4th period), in the fellows' room of the institute. All the discourses will be open to interested faculty members and qualified students of the university, to teachers of chemistry and chemists of the Pittsburgh district and to the membership of the institute:

1. Petroleum Refinery Technology, W. A. GRUSE

October 3. *Petroleum distillation practice*
October 10. *Chemical treatment of petroleum distillates*
October 17. *Properties and uses of petroleum products*

2. By-product Coke Technology, O. O. MALLEIS

October 31. *By-product coke-oven practice*
November 7. *Recovery of by-products from coke-oven gas*

3. Technology of Ceramic Products, S. M. PHELPS, TRACY BARTHOLOMEW, E. S. ROSS, B. A. RICE and E. J. CASSELMAN

November 14. *Raw materials and manufacture of refractories* (Mr. Phelps)
November 21. *Properties, uses and testing of refractories* (Mr. Phelps)
December 5. *Raw Materials and manufacture of Portland cement* (Mr. Bartholomew)
December 12. *Properties, uses and testing of Portland cement* (Mr. Bartholomew)
January 9. *Asbestos and magnesia products* (Mr. Ross)
January 16. *Vitreous enamels* (Mr. Rice)
January 23. *Window glass* (Mr. Casselman)

4. Manufacture of Explosives, H. L. COX

February 13. *Agricultural and mining explosives*
February 20. *Special military explosives*
February 27. *Detonators*

5. Paper Industry, MARC DARRIN

March 5. *Manufacture of paper pulp*
March 12. *Manufacture, properties and uses of paper products*

6. Leather Technology, M. C. WALSH

March 19. *Histology of skin and chemistry of tanning*
March 26. *Vegetable tannage*
April 2. *Mineral and other tannage*

7. Cereal Products, R. R. IRVIN

April 16. *Chemistry of cereals*
April 23. *Milling of cereals*
April 30. *Baking technology*

8. Fine-chemical Industry, L. H. CRETCHER

May 7. *Disinfectants and antiseptics*
May 14. *Anesthetics and hypnotics*
May 21. *Biochemical manufacturing processes*

STANDARDS FOR SCIENTIFIC AND ENGINEERING SYMBOLS AND ABBREVIATIONS

THE decision to undertake the standardization of scientific and engineering symbols and abbreviations as a national enterprise was made at a general conference called by the American engineering standards committee and held in the rooms of the American Society of Mechanical Engineers on February 13, 1923. Three organizations, the American Institute of Electrical Engineers, the Association of Edison Illuminating Companies and the American Society of Mechanical Engineers, made the original recommendations which resulted in the calling of this conference. Official representatives of national organizations attended this conference and after a full discussion they voted unanimously that this project should be undertaken, and that the American Association for the Advancement of Science, the National Research Council, the Society for Promotion of Engineering Education and the U. S. Bureau of Standards should be requested to accept joint sponsorship. Later the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society of Civil Engineers were invited to become joint sponsors.

The sectional committee on scientific and engineering symbols and abbreviations now consists of thirty members representing thirty-seven national organizations. It has organized nine subcommittees to which have been assigned the following divisions of the subject: (1) symbols for mechanics, structural engineering and testing materials, (2) symbols for hydraulics, (3) symbols for heat and thermodynamics, (4) symbols for photometry and illumination, (5) aeronautical symbols, (6) mathematical symbols, (7) electrotechnical symbols including radio, (8) navigational and topographical symbols, (9) abbreviations for scientific and engineering terms. The reports of these subcommittees will be prepared and issued separately.

The proposed standard on symbols for heat and thermodynamics was prepared by subcommittee No. 3, of which Dr. Sanford A. Moss, Thomson Research Laboratory, General Electric Company, is chairman. This subcommittee was organized on April 5, 1926, by direction of the executive committee of the sectional committee on scientific and engineering symbols and abbreviations for the purpose of recommending a list of standard symbols for use in the field of heat and thermodynamics. The proposed tentative standard has received the approval of the sub-committee and is now being circulated with a request for criticism and comment. Communications may be addressed to Preston S. Miller, secretary of the sectional committee, 80th Street and East End Avenue, New York, N. Y.

Mathematical and aeronautical symbols, developed

under the direction of the same sectional committee, were released to the technical press for review on July 20, 1927.

MEETING OF THE AMERICAN MUSEUM OF NATURAL HISTORY

A BOARD meeting of the trustees of the American Museum of Natural History was held on November 13. The business meeting was preceded by a luncheon given to the trustees by President Henry Fairfield Osborn at one o'clock. Besides reporting upon the general progress of the museum in its direct relation to exhibition and educational activities, the chairmen of the several departmental committees, headed by various members of the board, reported upon the several divisions coming under their particular charge. This division of individual trustee responsibility is a new phase in the museum program, and the chairmen of the several committees are selected by reason of personal interest in the furtherance of the respective departments, *i.e.*, Dr. J. Hamilton Rice has assumed responsibility for the development of the halls of geology and geography; George F. Baker, Jr., that of mineralogy and the Morgan hall of gems; Childs Frick, the department of vertebrate paleontology; Clarence L. Hay, the department of Mexican archeology; Junius S. Morgan, Jr., the Asiatic hall and Asiatic collections; Daniel E. Pomeroy, the African hall and African collections; Kermit Roosevelt is assigned to look after an extensive exhibition covering the mammals of the world; Dr. Leonard C. Sanford similarly takes care of the birds of the world; George T. Bowdoin, oceanic collections and the hall of ocean life. The preparation of this particular section is proceeding rapidly and will form one of the most important parts of the museum's exhibitions. Cleveland E. Dodge devotes his interest to a correct exposition of fishes, while Madison Grant has been assigned to the department of comparative anatomy; Ogden L. Mills, who for a long time has manifested a deep interest in the expansion of literature pertaining to natural history, is assigned to the library and printing; Felix M. Warburg, who is prominent and well-known throughout the state in educational circles, is in charge of education, and George D. Pratt, who was formerly conservation commissioner of the State of New York, has been assigned to conservation.

The trustees of the museum recently requested President Osborn to become curator-in-chief of the division of mineralogy, geology, geography and astronomy, and also assume the post of curator-in-chief of geology and paleontology, both of which he has accepted. The trustees, by resolution, expressed their thanks to President Osborn for his generous action in contributing to the permanent endowment fund of the museum the sum of $5,000 recently presented to him on his seventieth birthday, which, in accordance with his wishes, they have set aside to the endowment fund to be known as the Osborn paleontological research fund, the principal of which is to be invested and the income used only for the advancement of research.

The present amount of endowment in hand is $12,156,549, together with $2,004,500 contingent bequests, making a present and prospective endowment of $14,167,049. To keep pace with the educational demands upon the museum, there is urgent need for the receipt of $5,832,951, which would be sufficient to raise the total permanent endowment to $20,000,000. Because of the lack of these funds, the preparation of new halls and the installation of new specimens is restricted. The interest on the endowment fund is used solely for scientific research, scientific exhibition and popular education, not for either maintenance or building.

SCIENTIFIC NOTES AND NEWS

DR. H. E. IVES, of the Bell Telephone Laboratories, New York, and S. L. Kneass, mechanical engineer of Philadelphia, were presented with the John Scott medals and premiums of the Franklin Institute at a meeting on November 16.

KING ALBERT of Belgium has conferred a special agricultural decoration of the first class upon Dr. C. J. Galpin, in charge of the division of rural life and farm population, U. S. Bureau of Agricultural Economics; Asher Hobson, collaborator of that bureau and permanent delegate of the United States to the International Institute of Agriculture at Rome, and Miss Grace F. Frysinger, of the extension service.

PROFESSOR EMIL ABDERHALDEN, of Halle, and Professor Max Nonne, of Hamburg, have been nominated honorary members of the Royal Academy of Medicine at Rome.

DR. SAMUEL AVERY, for nearly twenty years chancellor of the University of Nebraska, recently retired with the title of chancellor emeritus and professor of research in chemistry. Dr. Avery will have a laboratory in the chemistry building, where he will devote himself to writing and research.

SIR ARCHIBALD GARROD has tendered his resignation of the office of Regius professor of medicine at Oxford University, as from December 31 next. Sir Archibald succeeded Sir William Osler in 1920.

DR. S. W. PARR, professor of chemistry at the University of Illinois, has been nominated for president by the executive committee of the Chicago section of the American Chemical Society.

DR. WILBUR A. NELSON, formerly state geologist of Tennessee, now professor of geology in the University of Virginia and state geologist of Virginia, was elected president of the Virginia chapter of the Society of Sigma Xi at a meeting held on October 17.

CLARE N. STANNARD was elected president of the Rocky Mountain Division of the National Electric Light Association at the recent convention in Colorado Springs.

ARTHUR H. ADAMS, assistant superintendent of manufacturing development at the Hawthorne, Illinois, works of the Western Electric Company, Inc., assumes, on December 1, the position of technical adviser to the president of the Manhattan Electrical Supply Company, New York City.

WALTER MCCLINTOCK has been appointed to a research fellowship in ethnology at the Southwest Museum in Los Angeles.

PAUL T. DIEFENDERFER, graduate student of the University of Chicago, has been appointed assistant in ethnology on the staff of the Bernice P. Bishop Museum, Honolulu. His field of work will be Samoa, where the museum is conducting an ethnological survey. Mr. Albert F. Judd and Mr. Bruce Cartwright, members of the Samoan expedition of the museum, have returned to Honolulu. Dr. Victor Pietschmann, ichthyologist in the University of Vienna and Bishop Museum fellow in Yale University, has arrived at Honolulu. He plans a study of the larval and young stages of Hawaiian fishes.

PROFESSOR ALBERT A. MICHELSON, head of the department of physics at the University of Chicago, has returned from Pasadena, California, where he had been attempting a repetition of his experiment on the speed of light. Professor Michelson attempted to send a beam of light on a round trip of 164 miles, but was unable to do so because of haze and unsatisfactory weather conditions at the Mt. Wilson Observatory.

AT the request of Dean J. L. Hills, of the college of agriculture, University of Vermont, the U. S. Department of Agriculture has detailed Dr. L. H. James, bacteriologist, and D. J. Price, engineer, to make special studies of the heating of hay in the barns of the flooded area in New England.

DR. F. H. H. ROBERTS, JR., archeologist for the U. S. Bureau of American Ethnology, returned from the field on October 21. Dr. Roberts has spent the summer excavating a post basket-maker village in northwestern New Mexico and doing reconnaissance work in southwestern Colorado and southeastern Utah. John P. Harrington, ethnologist for the bureau, left for California on October 26 to continue his researches on the Mission Indians of that state.

AT the request of the Canadian Geological Survey and the United States and Vermont Geological Surveys, Professor B. F. Howell, a member of the geology department at Princeton University, will make a special study of geological formations in Vermont next summer.

PROFESSOR G. H. CRESSE, of the University of Arizona, is spending his year of sabbatical leave at the University of Göttingen.

DR. GUSTAV BERGFORS, of the University of Upsala, Sweden, is visiting the United States in the interest of work in physical anthropology.

DR. MOSES GOMBERG, professor and head of the department of chemistry at the University of Michigan, will give the lecture on the Charles Frederick Chandler foundation in Havemeyer Hall, Columbia University, on December 16, at 8:15 P. M. Dr. Gomberg's subject will be "Free Radicals in Chemistry—Past and Present."

AT a meeting of the New York University chapter of the Sigma Xi, on November 18, a paper was read on "A New Method of studying Stream Flow," illustrated by photographic exposures taken 20,000 per second, by Baron C. Shiba, of the Aeronautical Research Institute of Tokyo. In the absence of Baron Shiba, the material was presented by Dr. Alexander Klemin, professor of aeronautical engineering at New York University.

THE Astronomical Society of the Pacific announces four illustrated popular lectures on the general subject "From Atom to Island Universe," being given by Dr. William F. Meyer, associate professor of astronomy in the University of Berkeley, in the auditorium of the Pacific Gas and Electric Company, San Francisco. The final lecture of the series will be given on December 19 at 8 P. M. on "The Night Sky in Winter."

PROFESSOR JAMES KENDALL, of the department of chemistry, Washington Square College, New York University, delivered a lecture at Yale University on November 9 on "Rare Earths and Isotopes." He also spoke on November 18 at the Brooklyn Polytechnic Institute on "The Life and Work of Svante Arrhenius."

E. A. HODGSON, director of the Dominion Seismological Service, Canada, addressed the geological conference at Harvard University on November 15 on "Current Seismological Problems in Eastern Canada and New England."

REMINGTON KELLOGG, of the U. S. Bureau of Biological Survey, will give an illustrated lecture in the administration building of the Carnegie Institution of

Washington on November 29 on the "History of Whales—their Adaptation to Life in the Sea."

DR. JOHN JOHNSTON gave an appreciation of the work of Josiah Willard Gibbs at a meeting of the Yale chapter of Sigma Xi, which was held in the Sterling Laboratory of Chemistry on November 16. The semi-centennial of the publication of Gibbs's work is being celebrated in Germany, France and Holland. The memory of Professor Gibbs will be perpetuated at Yale by the establishment of a permanent Gibbs endowment fund of $250,000, which has already been contributed.

DR. CHARLES SUMNER JONES, dean of the medical school at the University of Buffalo, died on November 16, aged sixty-nine years.

SAMUEL SANFORD, engineer, of the U. S. Bureau of Mines, has died at the age of sixty-three years.

DR. EMIL BÖSE, formerly of the bureau of economic geology of the University of Texas, died at Sabinal, Texas, on November 8, as the result of an automobile accident which occurred near Sabinal on September 9. At the time of his death Dr. Böse was in the employ of the Standard Oil Company, of California, and was working chiefly in northern Mexico and adjacent regions in Texas.

THE Indiana Academy of Science will hold its next meeting at Notre Dame from December 1 to 3.

THE Beta Beta Beta National Biological Fraternity will hold its biennial meeting at the time of the meeting of the American Association for the Advancement of Science at Nashville.

THE offer of the Minnesota section of the American Chemical Society made at the Detroit meeting in September, to act as host for the national meeting in September, 1929, has been accepted.

THE council of the Society for the Promotion of Engineering Education has voted to hold its annual meeting at Chapel Hill during the week of June 25, 1928. This is the first time since the formation of the society in 1892 that it has held a meeting south of Richmond, and by doing so next year, recognition is made of the marked advances in engineering education in the South.

THE new botany building of Wellesley College was dedicated on November 4 with appropriate exercises. A reception and inspection of the building at 10:30 was followed by a luncheon at Severence Hall. The guests returned to the lecture room of the new building for the afternoon program. President Pendleton opened the meeting with a word of welcome to the visiting botanists and a tribute to Professor Hallowell, founder of the department. Professor Margaret C. Ferguson, chairman of the department, introduced the speakers of the afternoon, who spoke briefly of their special fields, Professor Edward C. Jeffrey on anatomy, Professor Karl M. Wiegand on taxonomy, Professor George E. Nichols on ecology, Dr. Benjamin White on bacteriology and Professor Edward M. East on genetics. Dr. W. W. Lepeschkin, dean of the Russian Peoples University, Prague, was scheduled to speak at Alumnae Hall at 4:30 on the "Chemical and Physical Composition of Protoplasm." On account of the flood conditions, his arrival was delayed until late afternoon and his address was postponed until after the dinner in the banquet room of Alumnae Hall. The address of the evening was given by Dr. C. Stuart Gager, who chose for his subject "Wellesley College and the Development of Botanical Education in America."

THE United States Civil Service Commission announces an open competitive examination for associate aquatic biologist at $3,000 a year, to fill a vacancy in the U. S. Bureau of Fisheries, for duty at Beaufort, N. C. Applications must be received not later than December 1.

PLANS for the new William H. Welch Library of the Johns Hopkins Medical School have been completed by Edward L. Tilton, architect, of New York, and have been accepted by the university. Work on the new building will begin at once and it is expected to be completed within ten months. It will be erected near the School of Hygiene and Public Health, and will have a frontage of 156 feet and a depth of 70 feet. The style is Renaissance with the exterior material granite and limestone. The library was made possible by a gift of $750,000 from the General Education Board, which also agreed to give an additional $250,000 for maintenance of the library and the chair of the history of medicine if the university would raise $500,000 for maintenance.

REMOVAL of the Boyden station of the Harvard College Observatory from Arequipa, Peru, to Mazelspoort, South Africa, has been practically completed. A permanent establishment is to be erected on a hill several hundred feet above the plain on which Mazelspoort is situated, but pending the work of building a road to the permanent site, installing water and electricity and constructing a cement observatory, two or three of the smaller telescopes have been erected in the village. Dr. J. S. Paraskevopoulos, who has been for the past three years in charge of the Boyden Station when it was situated near Arequipa, Peru, is directing operations at the South African post. There will be seven or eight research observers stationed at

Hazelspoort when the Boyden Observatory has been completed, which will be about the middle of this winter.

THE Secretary of Agriculture, W. M. Jardine, conferred on November 14 with a committee, representing thirteen national agricultural and industrial organizations, on the question of enlarging activities in fundamental research in the Department of Agriculture. The committee, formed for the purpose of promoting agricultural research, is composed of Miss M. B. Bromberg, chairman, representing the American Sugar Cane League; the secretary of the American Dairy Federation, A. M. Loomis, and the director of the Northern Division of the National Fertilizer Association, H. R. Smalley. The organizations interested in this movement, having a combined membership of over 2,000,000, are: The National Grange, American Farm Bureau Federation, American Beet Sugar Manufacturers' Association, American Sugar Cane League, American Dairy Federation, American Seed Trade Association, Automobile Chamber of Commerce, Better Understanding Between Industry and Agriculture, National Canners' Association, National League of Commission Merchants, National Lumber Manufacturers' Association, Tanners Council of America and The National Fertilizer Association.

THE Italian *Gazzetta Ufficiale* publishes a royal decree providing for the reorganization of the National Research Council. The purposes of the council are to coordinate national activities in the various fields of science and its practical applications; to make recommendations to the government concerning laboratories for general or special researches; to furnish, on request, information and opinions to government boards on scientific subjects; to collect Italian bibliographic data on scientific and technical subjects and provide also for their diffusion in foreign countries, and to propose to the government the creation of scholarships, not only for the homeland but also for foreign countries.

ABOUT $200,000,000 is being spent each year in the United States for industrial research by industrial corporations and by the federal government, according to figures compiled by the National Industrial Conference Board. During the past six years the number of companies maintaining research departments or laboratories has increased from 578 to more than 1,000. Industries whose research expenditures were largest five years ago are those which have scored the greatest relative growth since then. In addition to industrial departments maintained by commercial organizations, the report states that 70 trade associations are spending about $15,000,000 a year in research and 152 colleges and technical schools about $1,500,000.

To promote, encourage and aid scientific investigation and research at the University of Wisconsin and to assist in providing means and machinery by which scientific discoveries of the faculty, the staff, alumni and students may be applied and patented, is the purpose of a newly organized corporation which has taken for its name the Wisconsin Alumni Research Foundation. This corporation, the management of which rests in a board of five trustees, has no capital stock, nor does it ever expect to pay either dividends or profits. The Research Foundation was organized following the discovery by Professor Harry Steenbock that antirachitic properties can be imparted by irradiation to foods in which this factor is lacking or deficient in amount. Dr. Steenbock is the first scientist to assign his invention to the foundation. It has been reported that the trustees have negotiated a contract with the Quaker Oats Company under the terms of which patent applications and possible litigation and the designing and construction of the necessary machinery will be financed by the latter. In return the Quaker Oats Company is granted the license to the Steenbock invention, for which it will pay a royalty which by the third year following the beginning of its commercial use will amount to $60,000 annually.

DEAN C. F. BAKER, of the college of agriculture of the University of the Philippines, at Los Baños, who died early in July, left his extensive collection of insects to the U. S. National Museum. This collection was formed by Professor Baker during his long residence in the Malay region. It contains types of hundreds of specimens which have been determined by specialists throughout the world, and in addition to the determined material it contains a large quantity of unstudied specimens. The U. S. Department of Agriculture has authorized one of its specialists, R. A. Cushman, an associate entomologist of the Bureau of Entomology, to cooperate with the National Museum in arranging for the packing and shipment of the collection to Washington. Mr. Cushman sailed from Seattle for the Philippines on October 11.

SEVEN hundred and fifty grains of radium from the Belgian Congo was presented to the University of Lille, France, on November 16, by the executive committee of the Franco-Belgian Relief Fund as an acknowledgement of the money raised by the university to aid Belgian sufferers in the World War. The presentation was made by Prime Minister Jaspar and M. Francqui, finance expert. The radium will be devoted to research and experimental purposes.

THE Reconstruction Hospital, of which Dr. William

Gilman Thompson formerly was president, receives $50,000 under the terms of his will. Dr. Thompson, who was professor of medicine at the Cornell University Medical College, also bequeathed to the New York Botanical Garden $5,000 and $10,000 to the New York Academy of Medicine.

UNIVERSITY AND EDUCATIONAL NOTES

NEGROES have given $150,259 to the $1,000,000 fund which has been raised for Howard University, Washington, to be devoted to the purpose of the medical school. Fifty-one Negroes gave amounts ranging from one thousand to ten thousand dollars.

A LEGACY of £2,000, bequeathed by the late Christopher Collins to the University of Birmingham, is to be added to the biological building fund.

DR. MILO HELLMAN, research associate in physical anthropology at the American Museum of Natural History, has been appointed professor of comparative dental morphology at the New York University College of Dentistry.

ASSOCIATE PROFESSOR H. J. ETTLINGER, of the University of Texas, has been promoted to a full professorship of mathematics.

DR. J. R. MAGNESS, physiologist in storage and transportation investigations of the U. S. Department of Agriculture, has been appointed head of the department of horticulture in Washington State College and of the division of horticulture in the experiment station.

DR. THURMAN B. RICE has been appointed associate professor of bacteriology and public health, and Dr. Frank Forry, associate professor of pathology at the Indiana University School of Medicine, Indianapolis.

DR. FREDERIC A. WOLL will head the department of hygiene of the College of the City of New York, beginning January 1.

W. L. GILLILAND, national research fellow at Harvard University, has been appointed instructor in chemistry at the University of Maine.

H. JENSEN, who has been connected with the department of chemistry of the University of Louisville as assistant professor, has accepted a position at the Johns Hopkins Medical School in the department of pharmacology in order to do research work on insulin.

J. O. COOPER has been appointed lecturer in zoology at Armstrong College, Newcastle-on-Tyne, in succession to Dr. A. D. Peacock, who is going to University College, Dundee, as professor of zoology.

DR. RALPH P. SMITH has been appointed to a position in the pathology department of Dalhousie University Medical School, Halifax, succeeding Dr. Albert G. Nicholls, who has resigned. Dr. G. S. Eadie has taken the position in the physiology department formerly occupied by Dr. N. B. Dreyer. Dr. Louis M. Silver has resigned as professor of medicine.

DISCUSSION AND CORRESPONDENCE

CONFUSING NAMES FOR A METEOR

Two contributors to SCIENCE have expressed themselves on the difficulty of extracting from supposedly intelligent people useful information on the fall of a meteor. When Mr. Jones announces, perhaps in a scientific publication, that he saw a meteor with a head the size of a golf ball and a tail six feet long fall in broad daylight, which burst over Lake Cochituate at a height of one hundred feet, the exasperated investigator learns little except that the meteor did not burst over that lake.

The purpose of this note, however, is to discuss another difficulty, that of several confusing names for the same meteor, and scientific men are themselves largely responsible for errors from this source. It has recently been intimated that much of the same confusion in another field results from the belief of certain individuals that coining a new name for a species is an easy way to gain publicity. We will discuss the treatment of a meteor which fell about twenty miles west of the University of Iowa on February 12, 1875, and the reader can judge for himself whether the publicity on the various new names suggested would be desirable.

This meteor fell in Iowa County, Iowa, largely on land owned by the Amana Society, with the closest towns the Amana villages of South Amana, High Amana and Middle Amana. Their chief village, Amana, and the other society villages, West Amana, East Amana and Homestead, are only a little farther away. Marengo is the closest town of any size.

Two University of Iowa men investigating the meteoric fall published preliminary notes, referring to it as the Iowa County meteor. A more definite designation is, however, desirable, and later in the year, when sufficient stones had been recovered to mark the field of the meteorites, one of the men published the name Amana, under which specimens were sent to Europe and the more complete monograph on the meteor published at a later date.

The preliminary note referred to the fall as occurring "near Marengo." As might be expected some picked on this as a name, and in modern catalogs Marengo is given as one of the alternate names for

the Amana meteor. This confuses the Amana meteor of February 12, 1875, with the Marengo meteor of March 27, 1894.

As was said before, the fall occurred some twenty miles west of Iowa City, and was investigated by men from the University of Iowa. Further, meteorites were shipped from Iowa City to various parts of the world. Hence the name Iowa City was attached. It does not appear in the latest catalogs directly, but in Farrington's catalog of "Meteorites of North America" one finds for the position of the fall the longitude and latitude of the University of Iowa. So the error is still with us.

The first stone recovered was found on the property of a Mr. Sherlock, and this stone, important as the only one not exposed to the elements for some months, was referred to as the Sherlock stone. Many were unable to grasp the distinction, and insisted on attaching the name to all the stones of the Amana fall. This is given as an alternate name in the latest catalogs.

When the extent of the meteoric fall became generally known, dealers sent representatives to the locality. These men made Homestead their headquarters, as that village is the most easily reached by rail of those conveniently near the fall. The dealers secured many specimens, and we find the name of their trading post, Homestead, given preference in some of the late publications. A recent book showing a map of the vicinity of the fall, and using the name Homestead, marks the position of that village but fails to show Amana and the other villages of the vicinity.

Several interesting items with no basis of fact appeared in the newspapers at the time. The prize should be awarded to a story sent out from West Liberty, forty miles east of the fall, which told of a big stone buried fifteen feet deep found near that town. This story convinced many that the University of Iowa scientists had committed a grave injustice in failing to use the name West Liberty for this meteor. At the St. Louis World's Fair of 1904, practically thirty years after the fall, the map of American meteorites showed the Amana fall as occurring at West Liberty. Even in Europe this has been given as the preferred name in museum catalogues.

C. C. WYLIE

UNIVERSITY OF IOWA

FIREBALLS AND NEW ENGLAND SCIENTISTS

THE study of the bright meteors often called fireballs, so bright that they attract wide attention and excite great interest among masses of people, differs in an important respect from that of the shooting stars of lesser brilliancy. The latter are noted for their periodicity, and for occasional showers of very numerous small meteors with some fireballs intermingled. But fireballs are generally scarce and, while there are signs of periodicity, in many cases they are certainly not members of the solar system, but appear sporadically. These two facts, and the impressive swift glare, burning train and occasional loud noises bring it about that they are for the most part observed by unskilled and unprepared observers, whose reports have to be elicited by appeals through the press and the radio broadcasting stations. The original observations are in general made without focussed attention or expectation of making any report, and the reports are made after a lapse of time from memory.

Schiaparelli plainly stated the remarkable fact of interstellar meteors, and von Niessl and his successor, Hoffmeister, have extended his work in quantity, and have shown that in some cases it is possible to group interstellar meteors as members of interstellar swarms. Continuous investigation of the facts is evidently highly desirable. This has been done in the United States by men of training and capacity from the time of Nathaniel Bowditch, and is now one of the functions of the American Meteor Society, whose president, Professor C. P. Olivier, has at intervals lately published studies of these bodies. It has, however, been plain that the whole continent is too large for one person or observatory to cover, and an attempt has been made to divide the United States and Canada into sections small enough for one institution in each. New England has been assigned to Harvard Observatory.

The object of this writing is to bring fireball observing to the attention of the readers of SCIENCE, and, in particular, to the attention of the New England members of the American Association for the Advancement of Science. The hope is that they may interest themselves in observing and reporting very bright meteors, comparable with a bright planet at least.

The Harvard Observatory has already dealt with recent fireballs, which occurred on November 15, 1925, December 29, 1925, and August 10, 1927. The first fell on a Sunday morning, the others in evening twilight. The cue for collecting the data was in each case a press notice in the morning papers the day following the fall. The means used in each case was an appeal for reports by eye-witnesses circulated in the newspapers and in the first two cases by radio broadcast also. The response was in each case rather overwhelming; there were received, in order, 140, 260, 249 reports more or less to the point. In the first case only one meteor was certainly in evidence; its position was determined in a general way as over southern Oxford County, Maine, and it was shown not to be a member of the Leonid swarm. The second case was shown not to be simple, but composite, there having

fallen within a few minutes many strikingly bright meteors in New England, New York and Pennsylvania. Seven of these could be identified with considerable certainty, and for one of them the computation of a parabolic orbit and a study of the train were possible. The last case involved the fall of about forty bright meteors within a few minutes, almost all in the New England area. Of these only four could be dealt with in sufficient detail to determine ending heights.

The characteristic quality of the reports received is for the most part incompleteness, and even in some instances vagueness. In the last case, about one hundred thirty hours were spent in acknowledging reports (by postal cards), in writing abstracts on index cards, to reduce the tedium of handling such varied stationery, and in sorting the observations into groups, each of which might reasonably be taken to represent a single meteor. When this was done, there remained forty-four reports which were too vague to be grouped, the chief reason being lack of any indication of the time of observation, and thirty-eight reports which roughly stated the time of observation, but were nearly useless because of vagueness in the statement of direction. Even among those grouped there were many uncertain.

The useful results obtained in these campaigns are in no proper relation to the population reached by the appeals, or to the time and energy applied. The investigations are too much of a *post-mortem* nature. The hope for improvement lies in two directions: one is the education of New England people to prepare them for fireball observation when fireballs come; the other is, the informing of the scientific personnel of the region as to what facts are to be noted while a fireball is in flight and immediately thereafter. By the wide-spread circulation of questionnaires whenever a fireball account appears in the papers, the population is being reached. And the scientists of New England are begged to note the following:

The important facts are, (1) duration of flight, (2) moment of apparition, (3) position of bursting or ending point, (4) apparent path. Then, the phenomena of the flight, and the moment of arrival of the detonation, if any; if there is a train left behind, its position and its changes in form.

(1) Seconds can be counted conveniently by the formula: one thousand one, one thousand two, one thousand three . . .; and the counting ought to be prolonged after the disappearance for comparison with the watch. While it is often impossible to read the second hand, this should not be omitted in the day time; then (2) follows by back reckoning. Each person has his own rate of counting.

(3) This involves close observation of landmarks and of the observer's position, on road or hillside or verandah, to be followed up by a return to the point with simple instruments. Such are the pocket compass (whose reading should be given without correction for declination) and a home-made astrolabe.[1] Better than instrumental measurements like these are exact references to position among the stars, or with relation to the moon or the sun, or to the position of the shadow of the observer's head; especially if the angles are sketched on the spot.

(4) Memory sketches of the apparent inclination are excellent. But the best record is of the apparent path and ending point among the stars. And no one should be frightened by a lack of knowledge of the constellations. In one instance a very accurate "fix" of a point on a meteor's path was given by a sketch of the path between two stars. These were marked "large star" and "small star," and stated to be "in the west." Only Vega and Altair could match the sketch at the stated time, though the New York farmer who made it probably never heard of Vega or Altair.

If fireballs would come only singly, the exact time of apparition might be of less importance for every single observer. But when they are for several minutes peppered all over several states, and several hundred people write about them, times of apparition become vital; without them the observations can hardly be sorted. Given time of apparition, the moment of arrival of the noise allows a calculation of the mean velocity of the sound and of the average temperature of the air along the sound-ray.

The changes in form of meteor trains give us almost our only information about the winds of the highest atmosphere. They should be noted and sketched carefully, and attempts should be made to photograph them. This means a wide open lens and a moderately long exposure, and careful record of the moments of opening and closing. A few photographic cross bearings on a great train would give valuable data, better than any visual work can.

WILLARD J. FISHER

[1] This is a card (a postal card or one of that size is convenient), with a pinhole pricked through near one edge, from which hangs a plumb-line. The plumb-line is a thread, pushed through the hole and fastened on the back, long enough so that the bob—a large button, a screw nut or a pebble—swings clear of the card. One sights along the edge of the card, clips the line against the card with thumb or finger, and marks the direction of the vertical by a line on each side of the thread. The angles can be measured afterwards with a protractor. The card, without the thread, marked, with all records written on it, dated and signed, should go to the computer. There is a somewhat more elaborate form which the Harvard Observatory proposes to send out on return postal cards for use in fireball campaigns like those described above.

ON THE LOSS OF THE FIFTH TOE IN CERTAIN SALAMANDERS

DR. G. K. NOBLE (in Osborn, *Amer. Nat.* LXI, p. 18, 1927) makes a statement regarding the loss of the fifth toe in salamanders which is liable to quotation and which is sufficiently misleading and general to merit correction. "There is abundant evidence in both the *Plethodontidae* and the *Hynobiidae* that the outer toe is usually lost at a single step (*i.e.*, mutation) and not by a gradual dwindling away."

Now there are forms in both families which never have more than four toes, and these of course give no evidence, but in the well-known species of *Hynobiidae*, which have either four or five toes, there are frequent cases of the fifth being rudimentary, which might mean a "gradual dwindling away" or rather that the loss of the fifth toe is, as are most size characters, due to several genetic factors, rather than to a single one.

In 317 specimens of *H. leechii*, there were ten cases of lack of fifth toe and two cases of a rudimentary one.

In *H. lichenatus*, of 50 specimens, there two cases of lack and fourteen of reduction.

In *H. sonani*, four specimens showed two cases of lack and six of reduction.

In *H. tsuensis*, 184 specimens showed one case of reduction.

H. ikishimae showed three cases of loss and eight of reduction in a series of 179.

In *nebulosus* ten specimens showed five cases of loss and five of reduction.

Thus twenty-two cases of complete loss are balanced by thirty-six of reduction, which makes it seem very much rather a "gradual dwindling away" in these cases than "loss at a single step."

For completeness sake it may be added that *H. keyserlingii* and its possible derivative *Batrachuperus* (with two species) always lack the fifth toe, and that one out of twenty specimens of *H. kimurai* has a fifth toe, but that no reduced cases have been reported in it, and that one out of 14 *H. retardatus* showed one case of loss. Schmalhausen (*Anat. Anz.* 37, p. 441, 1910) points out that in *keyserlingii* the fifth toe begins to develop, tarsale V developing only to fuse later with tarsale IV.

In the *Plethodontidae* two groups lack the fifth toe. *Manculus* with two forms derived from *Eurycea*, and *Hemidactylium* and *Batrachoseps* with several derived from *Plethodon*. No cases of reduction have been observed in *Eurycea*, or *Manculus* or *Hemidactylium*, and the loss here may be due to a single factor, but a specimen of *Batrachoseps attenuatus pacificus* (the most Plethodon-like type) has been reported by Van Denburgh (Proc. California Acad. Sci. (3), 4, p. 8) to have a rudimentary fifth toe.

The "abundant evidence" therefore, in the absence of which it would be permissible to suggest that the loss took place at a "single step," indicates rather that it took place at more than one step.

Since this evidence is largely set forth in my monographs of the two families in question, which were Noble's source of information, it seems strange to meet with his statement. I have therefore thought it appropriate to set down the known facts concerning digital loss in these families.

E. R. DUNN

SMITH COLLEGE

COD-LIVER OIL FOR "SNUFFLES" IN RABBITS AND PNEUMONIA IN GUINEA-PIGS[1]

"SNUFFLES" has long been one of the deadliest diseases in rabbits. The affected animals seem to have a very bad cold and as a result their nasal cavities are clogged with a heavy yellow discharge. In most cases death follows within a few days after the first symptoms appear. Many practical rabbit breeders house their animals in outdoor hutches where they can be exposed to direct sunlight. This keeps the animals in good health as far as snuffles is concerned. The breeders seem to be of the opinion that the fresh air is responsible for the health of their animals. It now seems that the ultra-violet rays in the sunlight bring about this effect.

Most experimenters with rabbits keep their animals indoors and for this reason are not able to expose them to sunlight. Experience here shows that when two per cent. of cod-liver oil is fed with the grain ration the same effect is produced as by direct sunlight. The grain ration fed is made up mostly of rolled oats, a good absorbent of the oil. In severe cases in which the animal is too weak or unwilling to eat the grain, it has been found serviceable to administer several cc. of the pure oil by means of a medicine dropper. When this is inserted into one corner of the mouth there is no difficulty experienced in causing the animal to swallow.

The oil replaces sunlight because of its high vitamin D content, this vitamin having approximately the same effect as ultra-violet rays. The vitamin A content is high also, but is not of very great importance since the alfalfa hay fed the animals furnishes it in sufficient quantity. When green alfalfa is fed the animals during the summer months they do not die of snuffles, but a considerable number cough, indicating that the vitamin D in the green alfalfa is not quite high enough to act as a complete preventive.

[1] Contribution No. 72 from the Department of Animal Husbandry.

Upon occasionally adding to the ration the usual amount of oil the cough ceases, and complete protection is afforded.

Rabbits have a certain form of snuffles known as nasal coccidiosis. This type has not been known to occur in the colony here and therefore it can not be stated to what extent the oil would act as a preventive.

For the past three winters the addition of the oil to the grain ration of guinea-pigs has been found very beneficial. The losses from pneumonia have been cut down very appreciably and there has been a general improvement in vitality. In previous years the animals were fed sprouted oats in addition to their grain and hay, but this was not sufficient. The sprouted oats is high enough in vitamin C to prevent scurvy but is either lacking or very low in vitamin D. When the latter was supplied by means of cod-liver oil the ration became comparatively perfect.

The feeding of liberal quantities of green alfalfa to guinea-pigs makes them practically immune to pneumonia. It would seem from this that for guinea-pigs the above green feed has sufficient vitamin D for protection. Either green alfalfa is higher in vitamin D than sprouted oats or, if it is not, protection is afforded because it is fed in much larger quantities.

There is still another possibility and that is that green alfalfa may be entirely or almost entirely lacking in vitamin D but contains some other substance which acts as a good substitute in building up resistance to either pneumonia or snuffles.

The present report is not intended to represent experimental work in nutrition but merely the observations of one interested in raising healthy animals for experimental work in other lines; in this particular case, genetics.

HEMAN L. IBSEN

KANSAS AGRICULTURAL
EXPERIMENT STATION

THE SCIENTIFIC PAPERS OF WILLARD GIBBS

DURING the last few months I have been trying in vain, both in this country and in London, to acquire a copy of Willard Gibbs's "Scientific Papers" (Volume I). It is certainly a sad commentary that in this age of cheap printing, when tons of printers' ink flow daily to record and disseminate the most trivial incidents, the scientific papers of the greatest physical chemist America has produced should be unavailable to those who need them.

It can not be said that Gibbs's papers are of historical interest only. Unlike most scientific publications of fifty years ago, his writings on thermodynamics are as useful to-day as they were when first published. Those who have patiently labored through his admittedly difficult writings are agreed that we are far from having exhausted the valuable material which lies hidden therein.

The publisher who would bring out a reprint of the old edition of Gibbs's papers would certainly perform a service to science. In the meantime, I shall be greatly obliged if any reader can inform me where a copy of the old edition can be bought.

Since writing the above, I have obtained from Professor R. G. van Name, of Yale University, through the kind offices of Dr. A. W. Kenney, a copy of the German edition of Gibbs's "Thermodynamische Studien" edited by Wm. Ostwald in 1892. I understand that Professor van Name, who is a near relative of Willard Gibbs, will bring out next year a new edition of Gibbs's Scientific Papers.

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A SPECIAL FEATURE OF THE SECOND NASHVILLE MEETING: SCIENCE FOR THE PEOPLE

INCREASINGLY from year to year we witness the further correlation of isolated scientific facts into broad "laws" of economic value and the application of these "laws" to the welfare of the people as a whole. Curious phenomena not known outside of laboratories twenty years ago combined with others equally uncanny are found to form broad basic principles which in one way or another influence the daily lives of each and every one of us. With this development there has arisen in the public mind a keen desire for enlightenment in regard to science as a whole, as well as in regard to each of the various branches into which it is divided.

In order to progress science must find support. A century ago science was supported chiefly by the scientific men themselves, because they alone appreciated the importance and the potential value of scientific work. Then others became interested, and still later industry took a hand, while at the same time the people as a whole began to accord generous support to scientific institutions, especially to those of their own creation. At the present time science in this country, and indeed everywhere, is very largely supported by the general public, either through money derived from taxes or by numberless direct donations.

With the growing support of science by the people goes hand in hand an increasing responsibility of science to the public. The people have a right to be informed of the facts of science, of the progress that is being made, and of what science means to them. Science can no longer stand aloof. At the present time one of the very greatest scientific needs is closer contact with the world at large—a better understanding between the scientific workers and those by whom most of them are supported.

For the Nashville meeting of the American Association and Associated Societies there has been arranged as a general session, a symposium on the broad subject of publicity for science; that is, the broad problem of furnishing to the people the information that they wish and to which they are entitled. Those taking part in the symposium, which will probably occupy both forenoon and afternoon of Wednesday, December 28, are to discuss the subject from the points of view of: (1) the worker in pure science, (2) the publisher of standard scientific books, (3) the publisher of popular scientific books, (4) the editor of popular scientific magazines, (5) the editor of a commercial scientific journal, (6) the newspaper syndicate, (7) the feature writer, (8) the local newspaper, and (9) Science Service.

Another general session at the approaching Nashville meeting will be devoted to an address on "Science and the Newspapers," to be given by Dr. William E. Ritter, organizer and till recently director of the Scripps Institution of Oceanography at La Jolla, California. Dr. Ritter is well known to zoologists and to biologists generally. He will discuss some fundamental aspects of the question of newspaper diffusion of scientific knowledge.

AUSTIN H. CLARK,
News Manager for the Nashville Meeting

THE THOUSAND-DOLLAR PRIZE TO BE AWARDED AT NASHVILLE

AN interesting feature of the annual meetings of the American Association and Associated Societies is the award of the American Association Prize. This award attracts the attention of the intelligent public generally as well as of professional science workers and other people specially interested in the advancement of knowledge. If not quite peculiar, it is at least unusual, for eligibility to consideration consists solely in presenting a noteworthy contribution at the annual meeting in convocation week and there are no restrictions as to subject. The prize is surely a very valuable thing in American science. The funds by which it is made possible have been given to the American Association by a very generous member who does not wish his name made public. Its concrete purpose is to help toward further scientific accomplishment some research workers who have already made a really noteworthy contribution. It is hoped that this financial help may make it possible for prize winners to continue their work on a high plane of scientific scholarship. Four annual awards have been made: Cincinnati, 1923–24; Washington, 1924–25; Kansas City, 1925–26; Philadelphia, 1926–27. The fifth award will be made at the close of the approaching Nashville meeting.

The following rules for the award of the prize have developed from the experience of four years. They have been approved by the executive committee of the association and are in effect for the Nashville award.

1. To be considered by the Committee on Prize Award a paper must have been read at a session of one of the several sections or at a session of one of the organizations meeting with the association at the annual meeting at which the award is made.

2. Any paper is to be considered only on the basis of work already accomplished, as represented by a finished manuscript, but it may be in part or in whole a summary of work that has been recently published elsewhere.

3. Secretaries of sections and secretaries of organizations meeting with the association are asked to send in to the Committee on Award, as early in the meeting as possible, nominations or suggestions as to what paper or papers of their respective programs should be considered by the committee. These suggestions are to be in writing and are to be sent in to the registration office, from which they are to be immediately transmitted to the committee.

4. A paper may have the recommendation of a section committee, or of a special committee organized by a section, for the consideration of worthy papers.

5. The prize-winning paper should represent a noteworthy contribution to the advancement of science. The Committee on Award is not to make any special attempt to select the *best* paper presented at the meeting.

6. Authors of papers considered need not be members of the American Association for the Advancement of Science, nor members of any associated organizations.

7. It is generally undesirable that the prize go to the same field of science, or to closely related fields, in two consecutive years.

8. Younger workers are to be generally considered before workers who are already well known for scientific research.

9. Under no circumstances is the prize to be divided; it is a single prize of $1,000.

10. The Committee on Award is to report the award to the permanent secretary either on the evening of the next to the last day of the meeting period or on the last day. (Usually there are very few sessions held on the last day, which is often Saturday.) The report is to be in writing, signed by the chairman of the Committee on Award. Under no circumstances is the award to be reported to the permanent secretary later than the last day

of the meeting period, which is to be Saturday for the second Nashville meeting.

11. During the deliberations of the Committee on Award, and until public announcement is made by the permanent secretary, the utmost secrecy is to be maintained. Even slight hints regarding possible prize winners are not to be released in any way before the award is announced. Announcement is made to all news agencies at once, by the permanent secretary through the news manager for the meeting.

The Committee on the Award of the Nashville prize consists of the members named below:

William H. Roever, *chairman;* professor of mathematics, Washington University, St. Louis, Mo.

Roger Adams, professor of chemistry, University of Illinois, Urbana, Ill.

William Duane, professor of biophysics, Harvard University, Cambridge, Mass.

Charles Schuchert, professor of paleontology, Yale University, New Haven, Conn.

Robert J. Terry, professor of anatomy, Washington University, St. Louis, Mo.

BURTON E. LIVINGSTON,
Permanent Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN AGAR MEDIUM FOR PLATING L. ACIDOPHILUS AND L. BULGARICUS

EXPERIENCE has demonstrated that *L. acidophilus* grows poorly in ordinary peptone sugar agar and that many strains of typical *L. bulgaricus* will not develop at all in this medium. Rettger and Cheplin[1] (1921) employed whey agar in their experiments. The addition of galactose to this medium has been found[2] (1922) to increase its value. The author[3] (1924) developed a casein-digest, milk powder-digest, galactose agar which proved to be quite satisfactory for colony study.

Further investigation has indicated that some strains of *L. acidophilus* and *L. bulgaricus* attain the best colony development in whey-galactose agar, while others reach their optimum growth in digest-galactose medium. As a rule, *L. bulgaricus* grows best in digest galactose agar. In order to insure satisfactory results, it has been necessary to employ both kinds of media in the study of *L. bulgaricus* colonies.

From the standpoint of the dairy laboratory, or of any laboratory, where occasional platings of these species are carried out, some objection has been raised to both the whey and the digest media because their preparation is rather difficult. A more simple medium and one which is easily prepared has appeared quite desirable.

While studying the effect of tomato juice upon the growth of different bacterial species, the author found that the addition of tomato extract to whey-galactose agar brought about a marked increase in the size of *L. acidophilus* colonies grown on the medium, and that it accentuated the x type colony characteristic. Further investigation showed that a medium containing tomato juice, peptone and agar fostered the development of as good colony growth as the more complicated media.

Experiments were carried out with the object of determining what proportions of peptone and tomato juice were necessary for optimum colony development.

The tomato juice was secured by filtering the liquid portion of canned tomatoes through filter-paper. Media were prepared containing 0.5 per cent. and 1 per cent. peptone and varying proportions of tomato juice.

The agar was prepared in the following manner:

Formula:
Difco peptone
Tomato juice
Water to make 1,000 cc.
Adjustment to pH 7.0
Agar—10 grams

Autoclave to dissolve agar; filter through a thin layer of absorbent cotton; distribute in desired containers, and sterilize by autoclaving at 15 lbs. steam pressure for 15 minutes. The reaction of the finished product is about pH 6.5.

Comparative platings were made, employing 24-hour-old milk cultures of 12 strains of *L. acidophilus* and 8 strains of *L. bulgaricus*. All agar platings were incubated in an atmosphere containing approximately 10 per cent. CO_2[4] (Kulp, 1926) for 48 hours. Whey-galactose and the digest-galactose agar platings of the same species were carried along under the same conditions as controls.

The results of this experiment and several others of like nature indicate the following:

1. Agar plating of *L. acidophilus* and *L. bulgaricus* made with an agar containing the proper concentra-

[1] Rettger, L. F., and Cheplin, H. A., 1921, "The Transformation of the Intestinal Flora, with special reference to the Implantation of Bacillus Acidophilus," Yale University Press.

[2] Rettger, L. F., and Kulp, Walter L., 1922, "A Note on the Choice of Culture Media for the Study of Lactobacillus, with special reference to the Carbohydrates employed," *Abstracts of Bacteriology*, Vol. 6, p. 24.

[3] Kulp, W. L., and Rettger, L. F., 1924, "A Comparative Study of *L. acidophilus* and *L. bulgaricus*," *Jour. Bact.* 9, 357–394.

[4] Kulp, W. L., 1926, "The Determination of Viable Lactobacillus Acidophilus," SCIENCE, Vol. 64, pp. 304–306.

tion of tomato juice bring out the optimum colony development of these two species. In all cases, this medium is as acceptable as whey-galactose agar or dibest-galactose agar, and as a rule it is preferable since the colonies of many strains on the tomato agar are decidedly larger and more characteristic than on either of the other media.

2. Incubation in an atmosphere containing approximately 10 per cent. CO_2 is desirable for agar platings of both species.

3. Two hundred to four hundred cc. tomato juice per liter plus 1 per cent. Difco peptone produces the most satisfactory medium.

4. Agar platings of *L. bulgaricus* strains which are very exacting in their growth requirements should be incubated for 72 hours.

No satisfactory explanation can be offered for the growth-stimulating effect of tomato juice upon *L. acidophilus* and *L. bulgaricus* unless it be in the light of an "accessory substance or substances."

Both of these species require carbohydrate for growth. The amount of sugar in tomatoes varies from two to four per cent.; it is made up chiefly of hexoses. Two hundred to four hundred cc. of tomato juice per liter fully satisfy the carbohydrate requirements of these organisms.

However, *L. acidophilus* develops poorly in ordinary nutrient agar containing added hexoses, and many strains of *L. bulgaricus* will not grow at all in such a medium, no matter what sugar is present. There must be some other factor in tomato agar, therefore, in addition to the carbohydrate, which stimulates the growth of these organisms.

WALTER L. KULP
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SPECIAL ARTICLES

THE ORIGIN AND DISTRIBUTION OF SCIENTIFIC MEN

THE fourth edition of the Biographical Directory of American Men of Science, which will be published in December, contains an appendix describing the methods that were used to select the scientific men who are designated in the book as those whose contributions to science have been of the greatest value. There were added in the third and fourth editions (1921 and 1927) 601 names to the thousand first selected in 1903 and reselected in 1909. In the book there will be given a statistical study of the origin and distribution of these scientific men, and it may be worth while to print in SCIENCE some of the data.

In the production of the 601 scientific men New York leads with 67, followed by Ohio with 49, Massachusetts with 48, Illinois with 45 and Pennsylvania with 41. The group of states next following consists of Iowa 27, Wisconsin 24, Missouri 21. The position of the North Central States is noteworthy, and is further emphasized by the situation in states having a productivity between 10 and 20, namely, Indiana 18, Connecticut 16, Minnesota 14, Maryland 13, Michigan 13, California 11, Kansas 11. The number of scientific men coming from the South Atlantic, South Central and Western divisions is small, though there has been some gain since 1903.

Of the leading thousand scientific men selected in 1903, Massachusetts produced 134 and Connecticut 40. At the time of their birth Boston was the intellectual center of the country. New York in proportion to its population had then produced about half as many scientific men as Massachusetts and Connecticut, the North Central States about one third as many. The situation had changed for the list of 1910. Reduced to comparable figures the birth rate of leading scientific men per million of population had fallen in Massachusetts from 109 to 85, in Connecticut from 87 to 57. In Michigan it had increased from 37 to 74, in Minnesota from 23 to 59, in Wisconsin from 45 to 54. The intellectual fecundity of the North Central States, as compared with New England, has now further increased, extending westward and southward to Iowa, Missouri and Kansas.

If the 601 scientific men are increased to 1,000 proportionately distributed, which is approximately the result that would have been obtained if 1,000 had been selected, the gains or losses of each state may be found. The situation in New England is ominous for the future. Every state has lost and it appears that the rural population is becoming intellectually sterile. Of the thousand leading scientific men in 1903, Maine had produced 29, of whom 19 ranked in the first 500. Of 601 scientific men mostly born less than 50 years ago, the state has produced six; if a thousand had been selected the most probable number would have been ten. It has consequently lost 19, two thirds of its productivity. Massachusetts has lost 54. Analogous conditions obtain in all the New England States and southward along the Atlantic. The losses of New York, New Jersey and Maryland, in spite of, or it may be because of, their enormous increase in wealth, are startling. Pennsylvania and Delaware remain nearly stationary; there are small gains in most of the South Atlantic and South Central States.

The losses of the eastern states are counter-balanced by the gains of the central states, notably Illinois, Minnesota, Iowa, Missouri, Kansas and Nebraska. All the central states have gained except Michigan,

though the gains in Ohio and Indiana are small. These three are the most eastern of the states and appear to be following in the wake of the Atlantic seaboard. Further to the west there tend to be moderate gains which predict a large future development. So indeed westward does the course of science take its way, but it is not gratifying if the eastern states do not equal the cultural nations of Europe before losing their leadership. This may indicate a waning of the world's great era in science.

Ten of the scientific men on the list of 1921 have died, giving an annual death rate of 4.7 per thousand, which is about normal for men of that age. Of the 591 remaining on the lists of 1921 and 1927, 122 live in New York, 57 in Massachusetts, 52 in Illinois and 47 in California. If the numbers are increased to 1,000 and proportionately distributed, it appears that in comparison with the thousand of 1906 Massachusetts has lost 49, whereas Illinois has gained 24 and California 23. Every New England state, as also New Jersey, Maryland, Virginia and North Carolina, have a smaller proportion of these leading scientific men than they had 21 years ago. New York has gained 11: Pennsylvania has lost two. Next to Illinois and California, Minnesota has the largest gain. The smaller gains or losses in other states show the real situation at the time and are significant, especially in view of the grouping by regions.

When we compare the birth places and residences we find that New York has acquired 55 more of the scientific men than it has produced, the individuals of course not always being the same. Massachusetts has gained 9, Connecticut 4, New Jersey 10 and Maryland 10, these representing men called to the universities. Illinois for the same reason has gained 7, Michigan 5 and Minnesota 4. In the other central states the loss has been large. One hundred and sixty, more than one fourth, of the scientific men were born in them and only 55 reside there. There are but few scientific men born in Washington while many are employed in that city by the government. Of the new group, three were born in the District of Columbia and 76 reside there. Eighty-six of the scientific men were born abroad, so they more than supply the excess in Washington and the balance remains nearly even for the different states.

In 1906 one half (501/1,000) of the leading scientific men of the United States resided in the North Atlantic States and somewhat more than one half (518/993) had been born there. In the short period of 26 years the proportion of those born in these states has fallen to one third (200/598) and the percentage of those residing there to 44.5 per cent. (263/591). The cities of the eastern seaboard depend in large measure on Europe for their population, on the central west for their wealth and for their leader They will face a difficult situation when immigratio is nearly cut off and centers of wealth and cultur develop toward the west. It might be supposed tha as wealth increases in the hands of a plutocracy, s scientific and other culture would increase in its cen ters. There has obviously been no change in nativ ability in the course of a few years. The only sug gestion here made is that the state universities an denominational colleges of the central and western states are more nearly in touch with the people tha the privately controlled universities of the east an have proved to be the better agencies for the selec tion and training of those having ability and idea interests.

The eastern universities provide education for mor men who become leaders in science than the state produce. As American students formerly went t Germany for advanced work, so in a later period the tended to congregate in the endowed universities o the Atlantic seaboard. The first degree of doctor o philosophy in the United States was given by Yal University in 1861, the first scientific man to receiv it being Josiah Willard Gibbs in 1863. Prior to 187 Yale had given 18 doctorates in the sciences, Harvar 4, Columbia and Cornell 2 each. Then was estab lished the Johns Hopkins University, opening a ne era of higher education and scientific research in th United States. In the following 20 years the John Hopkins conferred 179 doctorates in the sciences an 84 of the recipients (some had died) were on the lis of 1,000 scientific men of 1910. During this perio Columbia conferred 67 such degrees, Harvard 66, Yal 56, Cornell 33, Pennsylvania 22, Clark (opened i 1888) 21, Chicago (opened in 1892) 8, all other uni versities 66.[1]

Up to and including 1910, the universities of th United States had conferred 2,513 doctorates for wor in the sciences, the distribution being: Johns Hopkin 434, Chicago 276, Yale 271, Columbia 268, Harvar 267, Cornell 222, Pennsylvania 172, Clark 150, a others 453. Thus eight endowed universities awarde more than four fifths of these degrees. In 1926 ac cording to data compiled for the National Researc Council by Callie Hull and Clarence J. West ther were 740 doctorates conferred in the sciences, th numbers for the leading institutions being: Chicag 78, Wisconsin 53, Johns Hopkins 50, Columbia 4 Illinois 44, Cornell 43, California 38, Yale 38, Har

[1] These statistics concerning doctorates in the science are from an unpublished study. From 1898 to 1915 ther was printed each year in SCIENCE an article on doctorate conferred by American universities, including the name of the recipients and the subjects of the theses in th natural and exact sciences.

vard 35, Washington 32, Minnesota 30, Iowa 28, Ohio State 25. Thus Chicago in the central west is far in advance of the eastern privately controlled universities and the seven eastern universities which had conferred prior to 1910 nearly three quarters of all the degrees in 1926 conferred fewer than seven state universities of the north central states and California.

Of the institutions from which the 601 scientific men received their degrees, Harvard with 41 bachelors, 62 doctors of philosophy and three doctors of medicine, stands foremost as it did in 1903. It is, however, now surpassed by Chicago in the number of doctorates, as it was by the Johns Hopkins at the earlier period. After these three universities comes Columbia, followed by Yale, Pennsylvania, Cornell and California. The institutions whose graduates are in the twenties are Michigan, Minnesota, Princeton and the Massachusetts Institute; ranging from 18 to 12 are Wisconsin, Stanford, Indiana, Kansas, Illinois and Ohio State. The privately endowed universities still lead in the number of scientific men for whose education they were responsible usually some twenty to twenty-five years ago. They probably do not do so for the men graduated to-day, but we must wait another twenty years before the figures will be at hand. Many of the 41 bachelors who received degrees from Harvard and the 15 from Columbia and from Yale went to these universities from other institutions after they had planned their careers and the influence of the eastern endowed universities in the creation of scientific men is not large. The private colleges are also losing the influence that they formerly had. In the thousand of 1906 there were 23 graduates of Princeton and of Amherst, 16 of Wesleyan, 14 of Williams, 10 of Dartmouth and of Oberlin. For the contemporary list of 601 men the numbers are: Wesleyan 8, Princeton, Dartmouth and Williams 5, Amherst 4, Oberlin 2.

Another change that can not be regarded as wholly auspicious is the small number of the younger scientific men who have studied at foreign universities. In so far as this means such advance in our own institutions that it is needless to go abroad for special work it is gratifying. But it may result in lesser devotion to the ideals of scholarship and research that had their florescence in the German university of the nineteenth century. Of the thousand of 1906, 117 had studied in Berlin, 84 in Leipzig, 69 in Göttingen, 56 in Heidelberg, and a large proportion had received degrees from these and other German universities. Of the contemporary 601 only one has a degree from Berlin, none from Leipzig. This refers, of course, to men working in the period preceding the war. Perhaps now the various systems of unattached fellowships may lead to a larger international interchange of students. Before graduate students can afford to study abroad, we must, however, find a method by which younger scientific men receive positions in accordance with their ability rather than through the influence of the professors with whom they work.

The majority of scientific men still find their careers in universities. 358.5 (the decimal here and elsewhere referring to a divided position) of the 591 men hold academic positions and in the main earn their salaries by teaching. There are 95 connected with the research institutions that are the most notable development in scientific investigation of the present century. Sixty-two are engaged in industrial work, largely in the research laboratories of the corporations, where their work is not confined to applied science and will doubtless be more and more extended to the fundamental problems whose cultivation and by-products have an economic value far beyond their cost. Such work is besides only a proper return to society for the wealth acquired by monopoly. A public service corporation such as the American Telephone and Telegraph Company, whose profits are limited only by legal regulations, could easily and properly support and give the best facilities to scientific men engaged in research in physics, chemistry, mathematics and psychology. 74.5 of the men are employed by the government. Here again the work is largely but not wholly in applied science, and here again the most beneficial use of money collected by taxation would be the support of research that of all services is the most important for the nation and for the world.

Of these scientific men 60.7 per cent. hold academic positions as compared with 73.8 per cent. of those in the list of 1910. It has been recognized that there has been since the war a movement of scientific men from the universities to the research and industrial laboratories and we have here a measure of its extent. If the numbers are, as above explained, increased to a thousand we find that of this younger group the universities and colleges have lost 133. The research institutions have gained 88.5; the industrial laboratories and applied science 46; the government services 14.5. There is only one who may be classed as an amateur in the present list, as compared with 18 in 1910. We have never had in America a group of men, such as was represented in England by Darwin, Galton, Rayleigh and Huggins, who devoted themselves to scientific work without occupying a scientific position. The specialization of science and democratic institutions have now led to the practical disappearance of those who contribute significantly to the advancement of science without being professionally engaged in scientific or educational work. But we now have men who are professionally engaged in research.

The figures for the separate sciences show that nearly all mathematicians are teachers. Astronomy and pathology are especially well represented in the research institutions, geology and to a lesser extent physics, botany and zoology, in the government work, physics and chemistry in the industrial laboratories and applied science.

In treating the number of scientific men connected with different institutions we are in the main concerned with the present strength of the institutions rather than with changes in distribution, so all the scientific men are included. We have 1,176 instead of 1,000 as in the earlier lists. The competition for inclusion is now, however, more severe, for the list of 1906 included about one fourth of the scientific men of the country, whereas the present list includes only about one twelfth. The figures given are consequently relative. An increase of about 17.6 per cent. means that an institution has remained stationary in its relation to other institutions.

Harvard has on its faculties 89.5 of these leading scientific men and has gained 23 since 1906. Under the existing system of university administration honor should be given to Mr. Eliot and Mr. Lowell for maintaining high academic traditions. In 1906 Harvard had 66.5 of our thousand leading scientific men, Columbia 60, and Chicago 39. Now of 1,176 leading scientific men Harvard has 89.5, Chicago 53.5, and Columbia 46.5. It should also be noticed that Harvard has 21 of the younger men of the group of 250, as compared with 15 at Chicago and 7 at Columbia. Following these three universities are Yale with 42.5 and California and the Johns Hopkins bracketed with 40.5. Cornell, which comes next, has lost relatively. There then follow the three state universities, Michigan, Wisconsin and Illinois, of which Illinois has gained the most. Next come four endowed institutions, Stanford, Pennsylvania, Princeton and the Massachusetts Institute of Technology. Washington (St. Louis) is in the same group and has the largest gain. The only other universities having ten or more of these leading scientific men are Minnesota and the Ohio State. Apart from Columbia the universities that have lost most relatively are Missouri, Wesleyan, Syracuse, New York and Virginia.

The past twenty-six years have witnessed the development of endowed research institutions and the Carnegie Institution of Washington now stands next to Harvard and Chicago in the number of its scientific men of distinction. The Rockefeller Institute, limited to medical research, has also attained a high position. In this period the Carnegie Institution has grown from 7 to 47; the Rockefeller Institute from 3 to 19. The Boyce Thompson Institute, the Wistar Institute and the Mayo Clinic also show gains. The American Museum of Natural History and the New York Botanical Garden, with respectively 13 and of the scientific men, rank before most universities and show a gain since 1906. It is of interest that these institutions can flourish under support and control partly private and partly public.

The industrial laboratories of the corporations, like the endowed institutions for research, have enjoyed a notable growth which is scarcely measured by the 1 men recorded for the General Electric Company, the 10 for the Bell Laboratories and other parts of the Telephone System and the 5 for the Eastman Kodak Company. Industrial research, like advances in engineering, is not always recorded in scientific papers and is often a cooperative undertaking for which credit is not assigned to individuals. It is, however, to be noted that the number of leading scientific men under these three corporations has greatly increased and of 26 all but three belong to the group consisting mainly of younger scientific men.

The Bureau of Standards has during the period increased the number of leading scientific men in its laboratories from 8 to 23. The Geological Survey with 28.5, is the strongest group in a single science but relatively it has lost ground somewhat since 1906 as has also the Department of Agriculture. The Smithsonian Institution, with its government supported subsidiaries, has remained stationary, but this means a moderate relative loss. The U. S. Public Health Service has gained and some states and municipalities are now cooperating in this work.

In the book a table is printed showing the ten strongest departments in each science and their gain or loss since 1906. Harvard shows its leadership not only as a whole but in nearly every department. It stands first among universities in physics, chemistry, geology, botany, zoology, physiology and pathology, second in mathematics, third in astronomy and psychology, fourth in anthropology. There has been a gain since 1906 in every department except anatomy and psychology, though in several cases the gains are due only to the increased number of individuals on the present list. Chicago stands first in mathematics and second in zoology. Columbia stands first in psychology, but does not in any other science have a rank higher than fifth. The U. S. Bureau of Standards leads in physics and the Bureau of Ethnology in anthropology. By a wide margin the Carnegie Institution leads in astronomy, the U. S. Geological Survey in geology, the U. S. Department of Agriculture in botany and the Rockefeller Institute in pathology.

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